**Double beam experiment as a measure of hot carrier extraction**

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**Hot carrier solar cell design**

Energy filtering based on *thermionic emission*

Me-Contact  |  Light absorber layer  |  TCO-Contact

Aim: explore such a structure experimentally. Model structure:

| PbSe 0.5 μm | InP 0.5 mm |

Question: actual band alignment? X-ray photoelectron spectroscopy:

**Theoretical model**

Theoretical modelling is based on thermionic emission including exact Fermi-Dirac statistics:

Approximate equation for thermionic emission:

\[ J_n = A' T^2 \exp \left( \frac{-\Delta E_c}{kT} \right), \text{ where } A' = \frac{4\pi q m^* \hbar^2}{h^3} \]

Corrected equation for thermionic emission:

\[ J_n = B' T^2 \left[ \exp \left( \frac{-\Delta E_c}{kT} \right) + 1 \right] - \Delta E_c \frac{k}{h^2}, \text{ where } B' = \frac{4\pi q m^* \hbar^2}{h^3} \left( \sqrt{2} - 1 \right)^2 \left( \frac{1}{2} \right) \]

Simulation with experimental band offsets and bulk band gaps.

Normalization is necessary, because the intensity of the probing light remains constant independent of temperature:

\[ n_b = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \frac{dn}{dV} dV = \frac{2(2\pi m^* kT)^{3/2}}{h^3} \]

The concentration of carriers due to probing light remains either constant (band-band recombination), or decreases as square root of T (for dominating SRH recombination). The last assumption better fits the experimental data above.

**T(carriers) vs. \( \Phi \) of the heating light: linear conductivity model**

**Conclusion:** hot carrier filtering becomes experimentally accessible